



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

NOTES ON THE ERUPTION OF VESUVIUS IN 79 A.D.

MANY years ago I spent on various occasions considerable time at Pompeii in the study of certain fascinating problems connected with the topographical and structural history of that city and of Herculaneum. Naturally a good many other questions then suggested themselves which lay outside the field of my special inquiries. Certain of these to me subsidiary matters now appear possibly to have had some light thrown upon them by phenomena reported by careful scientific observers as exhibited in the two most spectacular explosive eruptions of volcanoes in recent years, those of Mont Pelée (Martinique), in 1902, and of Mount Katmai (Alaska), in 1912.

During the great eruption of Vesuvius in 79, the city of Herculaneum was overwhelmed by a tremendous river of liquid mud, which appears to have penetrated and filled every nook and cranny of the place, and accumulated to a depth of sixty to seventy feet. In the course of centuries this mud has hardened into a sort of tufa. The almost, if not quite, unanimous opinion of vulcanists has been that in volcanic eruptions (mud-geysers lie outside the question) no streams of mud are poured out from the interior of the earth, but they are formed externally by the downpour of accompanying torrential rains mixing with the lighter ash-ejecta from the craters. In such fashion have been explained the origin of the mud-flow that buried Herculaneum, and also certain less prodigious streams that coursed down the flanks of Mont Pelée in 1902. I had earlier found it difficult to conceive that *light* ejecta could have been lying at the moment on the appropriate slope of Vesuvius, and on the doomed city, in sufficient quantity to account for the magnitude and substantially uniform constitution of the rocky blanket that covers Herculaneum. But I bowed, as I am prepared to do still, to the wisdom of the scientists. When the eruption of Pelée occurred, and the reports upon it of the scientific investigators from various countries were accessible for study, these seemed at least to leave the

belief tenable that streams of mud had been poured out from certain vents in the mountain, and had not been in every case formed on the surface. I have now, after the lapse of fifteen years, read again certain of these reports, and venture to retain the same opinion. In the instance of Katmai there is more convincing testimony. Professor Robert F. Griggs, who has studied that volcano in repeated expeditions, is decidedly of the conviction, and exhibits cogent reasons for it, that a vent in the flank of Katmai, at the time of the great eruption of 1912, poured out an immense volume of ready-mixed mud from the bowels of the earth. This congealed torrent lies now in its bed to the depth in places of perhaps a hundred feet. There is some ground for raising the question again whether Herculaneum may not after all have been buried by a flood from a similar internal source.

Katmai provides us with yet another item of interest in the same connection. From the depths of Herculaneum have been rescued several scores of papyrus-rolls. These are in curious condition. Their external form is substantially unimpaired. The rolls have not been reduced to ashes, but their tissues have been completely carbonized. This condition has been explained as due to "slow chemical changes taking place in the course of centuries, such as have made over vegetable matter into coal." I hardly need point out that the time that has elapsed since the carboniferous age (to say nothing of other discordant elements in the comparison) is perceptibly greater than even the centuries that separate us from the destruction of Herculaneum. And I am informed that papyri buried in the sand-heaps of Egypt (through which oxygen might penetrate much more readily than through the rock-covering of Herculaneum), even those exhumed from the lower levels, where they have been ruined by the moisture that has mounted to them from the Nile, are by no means in the same condition as the Herculanean rolls. Of what character were these alleged "slow chemical changes"? Experts in chemistry, to whom I have referred the question, have not been able to provide a solution. Now comes in a suggestion from Katmai. Professor Griggs informs me (and exhibits a photograph to substantiate his statement) that a subsequent stream of water has eroded the aforesaid mud-flow, and has exposed trunks of trees that had been buried alive by the mud-torrent. These trunks retain their living shape and markings, but are at least superficially, if not throughout, carbonized. They have the

aspect of charcoal, as have the Herculanean rolls. Is it not possible, then, that the carbonized condition of the papyri was also due to no slow chemical process, but to the similar immediate effect of contact with volcanic mud raised to a very high temperature by contained superheated steam?

The late August Mau was a very decided opponent of the notion that the destruction of Pompeii was attended by widespread conflagration of its buildings. So briefly definite was his expression of dissent that I never ventured (much to my present regret) really to discuss the matter with him. He was of the opinion that there were indeed a very few fires, but these confined to very limited areas. He conceded that all, or substantially all, the wood preserved is in a charred condition, but confidently attributed this state to the old "slow chemical action," citing the (to me palpably unconvincing) example of the formation of coal. These beliefs he has expressed also in his books. If I had remarked that wood exhumed from ancient buildings elsewhere, that had not been subjected to fire, did not have the charred appearance of these Pompeian fragments, I conjecture his answer would have been the equally unconvincing one, that the chemical constitution of the enveloping volcanic ejecta in this case may be responsible for the difference. He also accounted on the same theory of slow chemical action for the not infrequent change of the yellow (ochre) wall-coloring to red, which sufficient heat would also have produced immediately, as in some cases in St. Pierre. My observation may have been at fault, but in watching daily the excavations in progress at Pompeii, and in inspecting the dump-heaps, recent and old, it appeared to me that much less trace of wood was in evidence than might reasonably have been expected from the structure even of ancient roofs of dwelling-houses; this, of course, on the theory that practically no wood had been destroyed by conflagrations, or had slowly rotted away.

I had also been struck by the attitudes of the Pompeian victims of Vesuvius, as shown by the casts of the cavities left by their bodies. It had generally been thought that at least those unfortunates who were out-of-doors in the city had stumbled on through the fallen and perhaps still falling ejecta in the attempt to escape, until, overcome with fatigue, they had collapsed, and been smothered by the ashes. On the other hand, their postures more frequently suggested to me the fall of persons struck down by some sudden blow. Yet the fallen ash in general

contains no masses capable of producing such an effect. I was unable to procure satisfactory evidence of the direction in which the bodies originally lay with reference to Vesuvius.

Upon the early reports of the terrific fiery blast from Pelée which brought almost instantaneous death to twenty thousand or more inhabitants of St. Pierre, I began to wonder whether it were not possible that some such blast as this had struck Pompeii. The position of the surviving ridge (Monte Somma) of the ancient peak of Vesuvius might indicate that, if any part of the boundary-wall of the mountain-top was blown away by the eruption, it must have been that on the southern side. This would leave a breach through which, reflected back from the Monte Somma cliffs, a destructive tornado might be directed straight against Pompeii. Such phaenomena were apparently unchronicled before the fate of St. Pierre, but I know no good reason for supposing that they had never before occurred. They were observed repeatedly in Martinique in 1902, and there is fair evidence that the contemporary eruption of the Soufrière in St. Vincent furnished additional examples, though happily of less devastating effect. I do not suppose they differed essentially from outbursts that take place in all explosive volcanic eruptions of considerable magnitude. But fortunately in most cases the cannon that fires the charge is aimed upward; in Martinique its fatal mouth was directed more horizontally.

The first blast at St. Pierre set in a sudden blaze the buildings of the city and even ships that lay in the harbor, and struck down into shapeless ruin walls that barred its way. A similar phaenomenon at Pompeii would account for the destruction of roofs and upper stories of dwellings, and for extensive conflagrations that consumed much woodwork, and left the remaining fragments charred.

When the book of Angelo Heilprin appeared (*Mont Pelée and the Tragedy of Martinique*, Lippincott, 1903), I found that he also had been struck by the possibility of identical elements in the fates of Pompeii and of St. Pierre. He appeared to be more certain than I was then, or am now, that Pompeii in fact suffered from a fiery blast like that which desolated the modern city. Yet some of his details about Pompeii were hardly accurate. The only one that I will mention here is concerned with the casts of the Pompeian victims. He observed properly that these casts (I think he had not seen all that have been made) exhibit atti-

tudes remarkably like those of corpses found along the streets of St. Pierre (p. 137). He also, however, called attention to another parallelism that really does not exist. In the St. Pierre case a considerable number of the persons struck down were also stripped of their clothing, apparently by the mechanical violence of the blast. Mr. Heilprin thought the Pompeian casts showed similar nude bodies, and for a similar reason. I do not so interpret the evidence of the casts. The victims were apparently in their indoor dress, but Mr. Heilprin seems to have had in mind the elaborate array of voluminous togas and pallas, taking his idea from Roman portrait statues in what we may call full-dress. Nor can I concede the accuracy of the (of course quite inconsistent) imaginative statement, rather quoted than made by him (p. 126), that "many of the bodies unearthed in the course of modern excavation were found in attitudes of action or motion of full composure, and of seeming indifference to impending danger."¹

Up to the time of the Pelée eruption I had been disposed to wonder whether the Pompeian victims who looked as though they had been suddenly struck down could have been killed by some deadly and swift-acting gas, like chlorine. The attendant slaves who apparently reported to the younger Pliny the circumstances of the death of their master, his uncle, mentioned a smell of sulphur in the air, preceding the approach of *flammae*. Sulphur-gases of various constitution are ordinary, if not invariable, companions of volcanic eruptions and other allied phenomena, and I am inclined to think that these terrified slaves would have been likely to attribute to burning sulphur any unknown and pungent odor perceived by them at the moment. It hardly seems safe to assume that these sulphurous exhalations killed Pliny at Stabiae, though his chronic difficulty about breathing may have been aggravated by them. But if they were distinctly perceptible at Stabiae, is it not possible that in a place so much nearer the source of the eruption as Pompeii, they might have become suddenly present in the atmosphere to an asphyxiating extent, even

¹ Mr. Heilprin also remarked upon the interesting fact that vessels of glass and clay from the ruins of Pompeii often show the same sort of deformation that was observed in similar vessels from St. Pierre, where the deformation could be accounted for only as due to the terrific heat to which they had been exposed; see also Plates XXI and XXII in his supplementary work, *The Tower of Pelée*, 1904.

if there was no such superheated tornado as was belched forth upon St. Pierre by *Pelée*? The observed high winds were in the direction from Vesuvius to Pompeii.

The testimony of the investigators appears to have been (I may have overlooked some more recent utterances) that no traces of chlorine were found in either the Martinique or the St. Vincent eruptions, except that Mr. Heilprin (p. 311n.) discovered "crusts or patches of greenish-yellow iron-chlorid" on some ejected boulders or bombs near *Pelée*. But chlorine and hydrochloric acid are usually found in products of volcanic eruptions, and it has been reported, whether correctly or not I cannot say, that articles of silver exhumed in the neighborhood of Pompeii (the "treasure of Boscoreale" is an illustrious example) were found to be coated with a chloride of silver. This condition also, like the carbonization of papyrus and wood, has been attributed to that same mysterious "slow chemical action." It might, indeed, have been thus produced, if the surrounding ejecta were impregnated with chlorine-products, or such gases have been slowly seeping upward through the earth from the volcano. In all probability gases of this constitution were thrown out by Vesuvius in its great eruption. Is it possible that they might have caused, or have effectively helped to cause, the destruction of life in Pompeii? If sea-water had gained access to the volcano through a fissure opened by the immediately preceding earthquakes, could its chlorides, through dissociation by action of the immense heat, have furnished enough gases to produce this effect?

I have thus, in my ignorance and assurance, ventured to suggest the reopening of some questions considered closed. They need the attention of specialists; the archaeologist cannot hope to settle them without the technical help of the vulcanist and chemist, nor the latter, perhaps, by themselves alone.

ELMER TRUESDELL MERRILL.

THE UNIVERSITY OF CHICAGO.